SNS COLLEGE OF ENGINEERING
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Artificial Intelligence & Machine Learning

Bayesian decision theory & Parametric and Non-parametric methods

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Parametric Machine Learning Algorithm

- Assumptions can greatly simplify the learning process, but can also limit what can be learned. Algorithms that simplify the function to a known form are called parametric machine learning algorithms.

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The algorithms involve two steps:

•Select a form for the function.

•Learn the coefficients for the function from the training data.

The assumed functional form is a linear combination of the input variables and as such parametric machine learning algorithms are often also called “linear machine learning algorithms“.

Nonparametric Machine Learning Algorithms

Algorithms that do not make strong assumptions about the form of the mapping function are called nonparametric machine learning algorithms. By not making assumptions, they are free to learn any functional form from the training data.

Examples of popular nonparametric machine learning algorithms are:

- k-Nearest Neighbours
- Decision Trees like CART and C4.5
- Support Vector Machines

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Benefits of Nonparametric Machine Learning Algorithms:

- **Flexibility**: Capable of fitting a large number of functional forms.
- **Power**: No assumptions (or weak assumptions) about the underlying function.
- **Performance**: Can result in higher performance models for prediction.

Limitations of Nonparametric Machine Learning Algorithms:

- **More data**: Require a lot more training data to estimate the mapping function.
- **Slower**: A lot slower to train as they often have far more parameters to train.
- **Overfitting**: More of a risk to overfit the training data and it is harder to explain why specific predictions are made.

Bayesian decision theory

Bayesian decision theory refers to the statistical approach based on tradeoff quantification among various classification decisions based on the concept of Probability(Bayes Theorem) and the costs associated with the decision.

In Statistical pattern Recognition, we will focus on the statistical properties of patterns that are generally expressed in probability densities (pdf's and pmf's), and this will command most of our attention in this article and try to develop the fundamentals of the Bayesian decision theory.

Prerequisites

Random Variable

A random variable is a function that maps a possible set of outcomes to some values like while tossing a coin and getting head H as 1 and Tail T as 0 where 0 and 1 are random variables.

Bayes Theorem

The conditional probability of A given B, represented by P(A | B) is the chance of occurrence of A given that B has occurred.

$P(A \mid B) = P(A,B)/P(B)$

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- By Using the Chain rule, this can also be written as:
- $P(A,B) = P(A|B)P(B)=P(B|A)P(A)$
- $P(A \mid B) = P(B|A)P(A)/P(B)$ ——- (1)
- Where, $P(B) = P(B,A) + P(B,A') = P(B|A)P(A) + P(B|A')P(A')$
- Here, equation (1) is known as the Bayes Theorem of probability

Our aim is to explore each of the components included in this theorem.

Step by step process of Bayes Theorem

- Prior or State of Nature
- Class Conditional Probabilities
- Evidence
- Posterior Probabilities


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